



GEHRIMED Usability Test Report

For §170.315(g)(3) Safety-enhanced design 2015 Certification

Report based NISTIR 7742 Customized Common Industry Format Template for Electronic Health Record Usability Testing and ISO/IEC 25062:2006 Common Industry Format for Usability Test Reports

GEHRIMED 4.0.0.1

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1 Executive Summary

A usability test of the GEHRIMED 3.0 cloud-based EHR was conducted from 9/11/2018 – 9/18/2018 in Asheville, NC by Geriatric Practice Management. The purpose of this test was to test and validate the usability of the current user interface and provide evidence of usability in the EHR Under Test (EHRUT).

During the usability test, 12 healthcare personnel served as participants and used GEHRIMED in simulated, but representative tasks.

This study collected performance data on 19 tasks typically conducted on an EHR:

1. Task 1: Clinical Decision Support – Configuration
2. Task 2: Demographics – Access Demographics
3. Task 3: Demographics – Record Demographics
4. Task 4: Demographics – Change Demographics
5. Task 5: CPOE Labs – Access Lab Orders
6. Task 6: CPOE Labs – Record Lab Orders
7. Task 7: CPOE Labs – Change Lab Orders
8. Task 8: CPOE Imaging – Access Imaging Orders
9. Task 9: CPOE Imaging – Record Imaging Orders
10. Task 10: CPOE Imaging – Change Imaging Orders
11. Task 11: Clinical Decision Support – Trigger a CDS Intervention
12. Task 12: Implants – Access a List of Active Implantable Devices
13. Task 13: Implants – Access an Implantable Device Detail
14. Task 14: Implants – Record a Unique Device Identifier
15. Task 15: Implants – Change the Status for an Implantable Device
16. Task 16: Problem List – Record a Problem in an Encounter
17. Task 17: Problem List – Access the Problem List
18. Task 18: Problem List – Change a Problem in the Problem List
19. Task 19: Clinical information reconciliation and incorporation

During the 90-minute one-on-one usability test, each participant was greeted by the administrator and asked to review and sign an informed consent/release form (included in Appendix 3); they were instructed that they could withdraw at any time. Participants had varying levels of prior experience with the HER. The administrator introduced the test and instructed participants to complete a series of tasks (given one at a time) using GEHRIMED. During the testing, the administrator timed the test and recorded user performance data on paper and electronically. The administrator did not give the participant assistance in how to complete the task.

Participant screens and audio were recorded for subsequent analysis.

The following types of data were collected for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Path deviations
- Time to complete the tasks
- Number and types of errors

- Participant's satisfaction ratings of the system

All participant data was de-identified – no correspondence could be made from the identity of the participant to the data collected. Following the conclusion of the testing, participants were asked to complete a post-test questionnaire. Various recommended metrics, in accordance with the examples set forth in the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, were used to evaluate the usability of GEHRIMED. Table 1 is a summary of the performance and rating data collected on GEHRIMED.

Performance/Rating Description	Mean Across Tasks
Task Success - Mean (%)	75.50%
Task Success - Std Dev (%)	26.58%
Task Path Deviation - Observed #	6.71
Task Path Deviation - Optimal #	6.26
Task Time - Mean (seconds)	51.18
Task Time - Standard Deviation (seconds)	36.02
Task Time Deviation - Mean Observed Seconds	17.59
Task Time Deviation - Mean Optimal Seconds	24.32
Task Errors Mean(%)	24.50%
Task Errors - Std Dev %)	26.58%
Task Rating	4.58
Task Rating - Standard Deviation	0.64

Table 1: Summary of the performance and rating data

The results from the System Usability Scale scored the subjective satisfaction with the system based on performance with these tasks to be: **82**.

In addition to the performance data, the following qualitative observations were made:

Major Findings

1. Most of the tasks were quickly performed by the users once they understood how to perform the tasks in the system.
2. The exception to this were the record demographics and the reconciliation tasks.
3. The *Race* and *Ethnicity* fields also caused significant confusion with users.

Areas for Improvement

1. Race and Ethnicity as well as the tabs on the Patient Details screen warrant investigation on ways to improve the user experience.
2. 17 recommendations have been provided across most of the areas accessed during this study.

2 Introduction

The EHRUT tested for this study was the GEHRIMED 4.0.0.1 cloud-based EHR. GEHRIMED is an Electronic Healthcare (EHR) software designed by experienced Long-Term Care (LTC) providers for use in LTC settings. GEHRIMED users are responsible for recording patient details and billing information, scheduling patient visits, entering patient record information, and recording patient encounters. Depending on the practice, these duties may fall to multiple individuals with different privileges in the GEHRIMED software. The usability testing attempted to represent realistic exercises and conditions.

The purpose of this study was to test and validate the usability of the current user interface and provide evidence of usability in the EHR Under Test (EHRUT). To this end, measures of effectiveness, efficiency and user satisfaction, such as task success, time on task, and task rating were captured during the usability testing.

3 Method

3.1 Participants

A total of 12 participants were tested on GEHRIMED. Participants in the test were Physicians, Nurse Practitioners, RN/LPNs, Coders, Scribes, and EHR Administrators. Participants were recruited by Karl Huber of GPM and were not compensated for their time. In addition, participants had no direct connection to the development of or organization producing GEHRIMED. Participants were not from the testing or supplier organization. Participants were given the opportunity to have the same orientation and level of training as the actual end users would have received.

For the test purposes, a recruitment questionnaire was used to solicit potential participants; the content for the questionnaire is provided in Appendix 1.

Recruited participants had a mix of backgrounds and demographic characteristics conforming to the recruitment screener. The following is a table of participants by characteristics, including demographics, professional experience, computing experience and user needs for assistive technology. Participant names were replaced with Participant IDs so that an individual's data cannot be tied back to individual identities. Participant demographics is provided in Appendix 6.

16 participants were recruited and 13 participated in the usability test. 1 participant failed to show for the study.

Participants were scheduled for 90-minute sessions with 60 minutes in between each session for the administrator to reset systems to proper test conditions. Spreadsheet was used to keep track of the participant schedule, and each participant's demographic characteristics.

3.2 Study Design

Overall, the objective of this test was to uncover areas where the application performed well – that is, effectively, efficiently, and with satisfaction – and areas where the application failed to meet the needs of the participants. The data from this test may serve as a baseline for future tests with an updated version of the same EHR and/or comparison with other EHRs provided the same tasks are used. In short, this testing serves as both a means to record or benchmark current usability, but also to identify areas where improvements must be made.

During the usability test, participants interacted with 1 EHR. Participants connected to the system remotely. The system was evaluated for effectiveness, efficiency and satisfaction as defined by measures collected and analyzed for each participant:

- Number of tasks successfully completed within the allotted time without assistance
- Time to complete the tasks
- Number and types of errors
- Path deviations
- Participant's satisfaction ratings of the system

Additional information about the various measures can be found in Section 3.9 on Usability Metrics.

3.3 Tasks

The tasks considered for summative testing were limited to only those twelve ONC 2015 Edition certification criteria specified in § 170.315(g)(3) and only for which certification is sought:

1. § 170.315 (a)(1) Computerized provider order entry (CPOE) – medications
2. § 170.315 (a)(2) Computerized provider order entry (CPOE) – laboratory
3. § 170.315 (a)(3) Computerized provider order entry (CPOE) – diagnostic imaging
4. § 170.315 (a)(4) Drug-drug, drug-allergy interaction checks for CPOE
5. § 170.315 (a)(5) Demographics
6. § 170.315 (a)(6) Problem list
7. § 170.315 (a)(7) Medication list
8. § 170.315 (a)(8) Medication allergy list
9. § 170.315 (a)(9) Clinical decision support (CDS)
10. § 170.315 (a)(14) Implantable device list
11. § 170.315 (b)(2) Clinical information reconciliation and incorporation
12. § 170.315 (b)(3) Electronic prescribing

Of these tasks the following 5 eRx related modules were removed from the list of modules to test based on GEHRIMED integration with DrFirst and their 2015 Certification:

1. § 170.315 (a)(1) Computerized provider order entry (CPOE) – medications
2. § 170.315 (a)(4) Drug-drug, drug-allergy interaction checks for CPOE
3. § 170.315 (a)(7) Medication list
4. § 170.315 (a)(8) Medication allergy list
5. § 170.315 (b)(3) Electronic prescribing

This reduced the number of tasks considered for summative testing to seven of the twelve ONC 2015 Edition certification criteria specified in § 170.315(g)(3) and only for which certification is sought:

1. § 170.315 (a)(2) Computerized provider order entry (CPOE) – laboratory
2. § 170.315 (a)(3) Computerized provider order entry (CPOE) – diagnostic imaging
3. § 170.315 (a)(5) Demographics
4. § 170.315 (a)(6) Problem list
5. § 170.315 (a)(9) Clinical decision support (CDS)
6. § 170.315 (a)(14) Implantable device list
7. § 170.315 (b)(2) Clinical information reconciliation and incorporation

Following is a detailed listing of the tasks performed during testing for each of the certification criteria:

1. (A9.1) Task 1: Clinical Decision Support – Configuration
2. (A5.1) Task 2: Demographics – Access Demographics
3. (A5.2) Task 3: Demographics – Record Demographics
4. (A5.3) Task 4: Demographics – Change Demographics
5. (A2.1) Task 5: CPOE Labs – Access Lab Orders
6. (A2.2) Task 6: CPOE Labs – Record Lab Orders
7. (A2.3) Task 7: CPOE Labs – Change Lab Orders
8. (A3.1) Task 8: CPOE Imaging – Access Imaging Orders

9. (A3.2) Task 9: CPOE Imaging – Record Imaging Orders
10. (A3.3) Task 10: CPOE Imaging – Change Imaging Orders
11. (A9.2) Task 11: Clinical Decision Support – Trigger a CDS Intervention
12. (A14.1) Task 12: Implants – Access a List of Active Implantable Devices
13. (A14.2) Task 13: Implants – Access an Implantable Device Detail
14. (A14.3) Task 14: Implants – Record a Unique Device Identifier
15. (A14.4) Task 15: Implants – Change the Status for an Implantable Device
16. (A6.1) Task 16: Problem List – Record a Problem in an Encounter
17. (A6.2) Task 17: Problem List – Access the Problem List
18. (A6.3) Task 18: Problem List – Change a Problem in the Problem List
19. (B2.1) Task 19: Clinical information reconciliation and incorporation

3.4 Procedures

All Participants were emailed date, time and connectivity information concerning their session. Once the session was started, participants were greeted; their identity was verified and matched with a name on the participant schedule. Participants were then assigned a participant ID. Each participant reviewed and digitally signed an informed consent and release form (See Appendix 3). The test administrator witnessed the participant's selection.

To ensure that the test ran consistently, one administrator performed all sessions, the recording software Camtasia was configured to record the sessions, and an online survey using Survey Monkey was used to provide instructions to the participants as well as record post-task ratings and the System Usability Scale ratings at the end of each session. Post session data review/logging and analysis occurred using the Camtasia software as well.

The usability testing administrator conducting the test was an experienced usability practitioner with 25 years of experience in software design and usability testing as well as graduate education in Human Factors Psychology.

Participants were instructed to perform the tasks (see specific instructions below):

- As quickly as possible making as few errors and deviations as possible.
- Without assistance; the administrator was allowed to give immaterial guidance and clarification on tasks, but not instructions on use.

For each task, the participants had access to a copy of the task via Survey Monkey.

Task timing began once the participant reviewed the instructions and indicated they were ready to start the task. The task time was stopped once the participant indicated they had successfully completed the task. Scoring is discussed below in Section 3.9.

Following completion of all tasks, the administrator (using Survey Monkey) gave the participant the post-test questionnaire (e.g., the System Usability Scale, see Appendix 5), and thanked each individual for their participation.

Participants' demographic information, task success rate, time on task, errors, deviations, verbal responses, and post-test questionnaire were recorded.

Participants were thanked for their time and the session was finished.

3.5 Test Location

All sessions were conducted remotely using web-based teleconferencing software (RingCentral Meetings).

Once the session had started, the administrator confirmed that the sessions were in a low-noise area and they were alone for the length of the session. This was so that user performance and feedback would not be influenced by additional parties.

3.6 Test Environment

GEHRIMED would be typically be used in a healthcare office or facility. However, because GEHRIMED is cloud-based, users can use it wherever the user has an internet connection.

In this instance, the testing was conducted remotely. Participants used RingCentral Meetings teleconferencing software to remotely view and control GEHRIMED running on the test administrator's machine. The participants used their remote system when interacting with GEHRIMED.

The test computer used the following settings:

1. Operating System: Windows 10
2. RAM: 16 Gb
3. Screen Resolution: 1920x1080

GEHRIMED was accessed through the Chrome browser application, on the test administrator's machine. The GEHRIMED environment was the GPM 2015 Certification test environment using a WIFI connection.

3.7 Test Forms and Tools

During the usability test, various documents and instruments were used, including:

1. Camtasia Recorder
2. Chrome Browser
3. GHERIMED application (using Chrome)
4. Moderator's guide (found in Appendix 2)
5. Informed Consent form (using Survey Monkey via Chrome) (found in Appendix 3)
6. User Guide excerpts (PDFs using Chrome)
7. Task instructions with post-task rating questionnaires (found in Appendix 4)
8. Post-test questionnaire (found in Appendix 5)

The participants accessed all tools and documents using Chrome in a single window with multiple tabs.

The participant's interaction with GEHRIMED was captured and recorded digitally with screen recording test software (Camtasia Recorder) running on the test machine.

3.8 Participant Instructions

The administrator read the following instructions aloud to each participant (also see the full moderator's guide in Appendix 2):

Introduce yourself

Thank them for participating

Reaffirm the session will take less than 90 minutes

Share screen

Ask them to read the consent and make a selection to consent or not

Explain all of the tabs in the browser

Discuss the session

1. We are interested in how easy (or difficult) GEHRIMED is to use, what's useful, and how we can improve it.
2. You will be asked to complete tasks on your own trying to do them as quickly as possible with the fewest possible errors or deviations.
 - a. Do not do anything more than asked.
3. If you get lost or have difficulty I cannot answer or help you with anything to do with the system itself.
4. Please save your detailed comments until the end of a task or the end of the session when we can discuss freely.
5. Please be honest with your opinions. Your participation and feedback help us identify and prioritize improvements to GEHRIMED.
6. The version of the product you will be using today is in a test environment. Because it is a test environment some of the data may be incomplete or not make sense as it is placeholder data.

The general flow of the session will be as follows:

1. You will have a chance to read the instructions
2. You will have a chance to review an abridged version of the user guide you would normally have available and ask any questions about what you reviewed for clarification.
 - a. These are the other tabs in the browser
 - b. Some guides are for multiple tasks
 - c. You may close the tabs for sections that are finished
3. You will be given an opportunity to perform various tasks.
 - a. Feel free to refer back to the instructions and the user guides as much as you want while performing the task
4. When finished with each task, you will have a chance to rate the task.

5. We will then move to the next task.
6. When all tasks are finished you will fill out a short survey.

At the end of each task please let me know you are done by saying something like “I’m done” or “I’m finished”. If you feel you cannot complete a task, please let me know.

If for whatever reason you need to stop and can’t continue the session let me know and we will stop the session.

Do you have any questions or concerns so far?

Once all questions were answered the participants began the tasks.

Participants were then given 19 tasks to complete. Tasks are listed in Appendix 4.

3.9 Usability Metrics

According to the *NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records*, EHRs should support a process that provides a high level of usability for all users. The goal is for users to interact with the system effectively, efficiently, and with an acceptable level of satisfaction.

To this end, metrics for effectiveness, efficiency and user satisfaction were captured during the usability testing. The goals of the test were to assess:

1. Effectiveness of GEHRIMED by measuring participant success rates and errors
2. Efficiency of GEHRIMED by measuring the average task time and path deviations
3. Satisfaction with GEHRIMED by measuring ease of use ratings

DATA SCORING

Table 2 details how tasks were scored, errors evaluated, and the time data analyzed.

Measures	Rationale and Scoring
<p>Effectiveness: Task Success</p>	<p>A task was counted as a “Success” if the participant was able to achieve the correct outcome, without assistance, within the time allotted on a per task basis.</p> <p>The total number of successes were calculated for each task and then divided by the total number of times that task was attempted. The results are provided as a percentage.</p> <p>Task times were recorded for successes. Observed task times divided by the optimal time for each task is a measure of optimal efficiency.</p> <p>Optimal task performance time, as benchmarked by expert performance under realistic conditions, is recorded when constructing tasks. Target task times used for task times were operationally defined by taking multiple measures of optimal performance and multiplying by a factor of 1.5 that allowed some time buffer because the participants are presumably not trained to expert performance. This ratio was aggregated across tasks and reported with mean and variance scores.</p>
<p>Effectiveness: Task Failures</p>	<p>If the participant abandoned the task, did not reach the correct answer or performed it incorrectly, or reached the end of the allotted time before successful completion, the task was counted as an “Failures.” No task times were taken for errors.</p> <p>The total number of errors was calculated for each task and then divided by the total number of times that task was attempted. Not all deviations were counted as errors. This was expressed as the mean number of failed tasks per participant.</p>
<p>Efficiency: Task Deviations</p>	<p>The participant’s path (i.e., steps) through the application was recorded. Deviations occurred if the participant, for example, went to a wrong screen, clicked on an incorrect menu item, followed an incorrect link, or interacted incorrectly with an on-screen control. This path was compared to the optimal path. The number of steps in the observed path is divided by the number of optimal steps to provide a ratio of path deviation.</p>
<p>Efficiency: Task Time</p>	<p>Each task was timed from when the administrator said “Begin” until the participant said, “Done.” If he or she failed to say “Done,” the time was stopped when the participant stopped performing the task. Only task times for tasks that were successfully completed were included in the average task time analysis. Average time per task was calculated for each task. Variance measures (standard deviation and standard error) were also calculated.</p>

Measures	Rationale and Scoring
<p>Satisfaction: Task Rating</p>	<p>Participant’s subjective impression of the ease of use of the application was measured by administering both a simple post-task question as well as a post-session questionnaire. After each task, the participant was asked to rate “Overall, this task was:” on a scale of 1 (Very Difficult) to 5 (Very Easy). These data are averaged across participants. ¹²</p> <p>Common convention is that average ratings for systems judged easy to use should be 3.3 or above.</p> <p>To measure participants’ confidence in and likeability of GEHRIMED overall, the testing team administered the System Usability Scale (SUS) post-test questionnaire. Questions included, “I think I would like to use this system frequently,” “I thought the system was easy to use,” and “I would imagine that most people would learn to use this system very quickly.” See full System Usability Score questionnaire in Appendix 5.</p>

Table 2: Details of how observed data were scored.

4 Results

4.1 Data Analysis and Reporting

The results of the usability test were calculated according to the methods specified in the Usability Metrics section above. Data for all participants have been included. The usability testing results for GEHRIMED are detailed below (see Table 3).

Task	N	Task Success	Path Deviation	Task Time In Seconds		Errors	Task Ratings (5=Very Easy)
(metric) Description	#	Mean (Std Dev)	# Observed /Optimal	Mean (Std Dev)	Deviation Observed /Optimal	Mean (Std Dev)	Mean (Std Dev)
Task 1: Clinical Decision Support – Configuration (A9.1)	12	69.44% (33.02%)	11.00	59.67 (47.68)	22.64/28.50	30.56% (33.02%)	4.50 (0.80)
Task 2: Demographics - Access Demographics (A5.1)	12	91.67% (19.46%)	11.00	63.67 (66.61)	35.07/19.50	8.33% (19.46%)	5.00 (0.00)
Task 3: Demographics - Record Demographics (A5.2)	12	58.33% (31.98%)	19.00	142.67 (43.78)	59.29/63.00	41.67% (31.98%)	4.00 (1.04)
Task 4: Demographics - Change Demographics (A5.3)	12	63.47% (33.58%)	15.08	79.42 (35.72)	18.57/49.50	36.53% (33.58%)	4.67 (0.65)
Task 5: CPOE Labs - Access Lab Orders (A2.1)	12	84.72% (27.94%)	2.00	12.42 (4.36)	3.14/7.50	15.28% (27.94%)	4.92 (0.29)
Task 6: CPOE Labs - Record Lab Orders (A2.2)	12	69.44% (40.72%)	4.00	32.80 (22.45)	0.93/22.50	30.56% (40.72%)	4.67 (0.65)
Task 7: CPOE Labs - Change Lab Orders (A2.3)	12	83.33% (24.62%)	5.00	28.00 (16.98)	3.00/21.00	16.67% (24.62%)	4.83 (0.39)
Task 8: CPOE Imaging - Access Imaging Orders (A3.1)	12	95.83% (14.43%)	2.00	12.67 (10.98)	1.86/9.00	4.17% (14.43%)	4.92 (0.29)
Task 9: CPOE Imaging - Record Imaging Orders (A3.2)	12	81.94% (27.02%)	4.00/4	76.75 (54.23)	37.29/28.50	18.06% (27.02%)	4.58 (0.90)
Task 10: CPOE Imaging - Change Imaging Orders (A3.3)	12	100.00% (0.00%)	5.00/5	16.00 (11.88)	0.21/13.50	0.00% (0.00%)	4.92 (0.29)
Task 11: Clinical Decision Support - Trigger a CDS Intervention (A9.2)	12	66.05% (36.91%)	7.00/7	60.58 (64.41)	24.93/27.00	33.95% (36.91%)	4.50 (1.17)

Task	N	Task Success	Path Deviation	Task Time In Seconds		Errors	Task Ratings (5=Very Easy)
(metric) Description	#	Mean (Std Dev)	# Observed /Optimal	Mean (Std Dev)	Deviation Observed /Optimal	Mean (Std Dev)	Mean (Std Dev)
Task 12: Implants - Access a List of Active Implantable Devices (A14.1)	12	92.71% (25.26%)	2.00/2	13.75 (10.97)	4.29/7.50	7.29% (25.26%)	4.58 (0.79)
Task 13: Implants - Access an Implantable Device Detail (A14.2)	12	100.00% (0.00%)	2.00/2	12.17 (4.80)	2.93/7.50	0.00% (0.00%)	4.75 (0.62)
Task 14: Implants - Record a Unique Device Identifier (A14.3)	12	80.56% (29.16%)	5.00/5	57.83 (46.02)	27.07/22.50	19.44% (29.16%)	4.50 (0.67)
Task 15: Implants - Change the Status for an Implantable Device (A14.4)	12	58.61% (31.80%)	3.00/3	48.17 (36.71)	21.79/19.50	41.39% (31.80%)	4.50 (0.52)
Task 16: Problem List - Record a Problem in an Encounter (A6.1)	12	65.28% (33.68%)	7.09/7	36.09 (17.07)	1.36/27.00	34.72% (33.68%)	4.83 (0.58)
Task 17: Problem List - Access the Problem List (A6.2)	12	91.67% (28.87%)	0.09/0	11.73 (10.85)	3.21/6.00	8.33% (28.87%)	4.92 (0.29)
Task 18: Problem List - Change a Problem in the Problem List (A6.3)	12	48.19% (32.12%)	6.17/6	71.75 (90.60)	37.50/24.00	51.81% (32.12%)	4.08 (1.08)
Task 19: Clinical information reconciliation and incorporation (B2.1)	12	33.19% (34.46%)	17.11/17	136.33 (88.18)	29.14/58.50	66.81% (34.46%)	3.42 (1.16)

Table 3: Detailed breakdown of usability test results.

The results from the SUS (System Usability Scale) scored the subjective satisfaction with the system based on performance with these tasks to be: **82**. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

4.2 Discussion of the Findings

4.2.1 Effectiveness

Based on the success data most users were able to perform the tasks on their first attempt. Users had a 100% task success rate for two of the tasks and a >90% task success rate for an additional 4 tasks. All but 2 tasks had a >50% task success rate.

Only 1 task (task 19: reconciliation) appeared to be difficult for most users with a success rate of only 33%. Very few tasks were total failures (user was never able to complete the task at some point). No tasks were total failures across all users.

4.2.2 Efficiency

Familiarity with each task significantly impacted each user's task deviations and time on task. The less familiar the user was with a task, the more deviations occurred and the longer the task took to complete. Although excerpts from the user guide were available, users did not always review them before performing a task.

When users were very familiar with tasks, they performed the tasks more quickly but appeared to follow the paths that were familiar to them which were not always optimal.

4.2.3 Satisfaction

Overall users were satisfied with the various tasks performed. The mean rating across tasks was 4.58 (out of a possible rating of 5 being very easy). 18 of 19 tasks had a mean rating above 4.0. One of the tasks had a mean rating of 5.0. The one task below 4.0 had a mean rating 3.42. (Common convention is that average ratings for systems judged easy to use should be 3.3 or above.)

The System Usability Scale (SUS) post-test questionnaire rating for the system overall supported the findings above. The results scored the subjective satisfaction with the system based on performance with these tasks to be: **82**. Broadly interpreted, scores under 60 represent systems with poor usability; scores over 80 would be considered above average.

4.2.4 Major Findings

Most of the tasks were quickly performed by the users once they understood how to perform the tasks in the system.

The exception to this were the record demographics and the reconciliation tasks. Both tasks were the only ones which took the users more than 80 seconds on average to complete (taking an average of 142 and 136 seconds respectively). Further, the reconciliation task had the largest number of errors, >50% more than any of the other tasks.

The other area where users struggled was with the *Race* and *Ethnicity* fields when on the *Edit Patient* screen. Users were confused by the aggregated data options in both lists and were consistently hesitant on what to select when they viewed the lists.

In addition, many users spent a significant amount of time referencing the user guides in order to perform the tests.

4.2.5 Areas For Improvement

There are several areas which can be improved.

Some areas warrant investigation on how to approach issues identified in this study while other areas can have recommendations provided immediately.

Following is a listing of issues warranting investigation on how to improve the user interface:

1. Race and Ethnicity input flow and data lists are confusing to the users.
2. Patient Detail tabs are not easy to navigate because some areas are hidden in drop-down tabs.

Following is a listing of recommendations:

3. Edit Patient
 - a. Change the *Gender* label to *Sex*.
4. Lab Orders
 - a. Change the *Test Name* and *Test Number* fields to work like the *Search* field and remove the *Search* field.
 - b. Make the *Test Name* and *Test Number* fields read-only once an order is created.
5. Diagnostic Imaging Orders
 - a. Change the *Request* field to work like the *Search CPT* field and remove the *Search CPT* field.
 - b. Make the *Request* field read-only once an order is created.
6. Implantable Devices
 - a. In the device list, swap the *Device Description* and *Unique Device Identifier* columns
 - b. Change the *Inactivate* button from displaying an X to display the word "Inactivate".
 - c. On the details dialog change the buttons to a *Close* button.
 - d. On the new dialog change the *Unique Device Identifier* label to display a more accurate label for what happens with that field.
 - e. Alternatively, for C and D above make the details dialog editable with *Status* as the editable field and remove the inactivate functionality from the list.
 - f. On the new dialog disable the *Save* button until all required fields are populated.
7. Patient Details Problem List
 - a. Remove the link from the name and display the *Edit* icon button next to the name as the way to edit a problem.
8. Reconciliation
 - a. Reconciliation matching screen
 - i. Separate the imported patient from others in the list.
 - ii. Provide a separate button to process the imported patient as a new patient.
 - b. Reconciliation data selection screen
 - i. Provide a warning dialog if no changes have been made in the Medications tab.

- ii. Provide a warning dialog if no changes have been made in the Medication Allergy tab.
 - iii. Provide a warning dialog if no changes have been made in the Problem List tab.
- 9. User Guide Access
 - a. Help content should be made available in the application as a help system
 - i. Create context sensitive help on every screen.
 - ii. Create searchable help available at a main screen such as the GEHRIMED dashboard.
 - b. If a Help system is not implemented then, at a minimum, the user guide needs to be accessible from the application via a link to the PDF file.

5 Appendices

The following appendices include supplemental data for this usability test report. Following is a list of the appendices provided:

- 5.1 Appendix 1: Recruiting Questionnaire
- 5.2 Appendix 2: Moderator's Guide
- 5.3 Appendix 3: Informed Consent Form
- 5.4 Appendix 4: Task Instructions with Post-Task Rating
- 5.5 Appendix 5: Post-Test Questionnaire (System Usability Scale)
- 5.6 Appendix 6: Participant demographics

5.1 Appendix 1: Recruiting Questionnaire

The purpose of the recruiting questionnaire was to ensure that the participants selected represent the target user population as closely as possible. With that in mind, screening questionnaire recipients were selected from the existing user population.

The recruiting questionnaire was implemented online using the survey tool Survey Monkey. The following content is the text of the questionnaire.

2018 GEHRIMED Usability Test Preliminary Survey

Geriatric Practice Management (GPM) is recruiting individuals to participate in a remote usability study for our EHR system GEHRIMED. We would like to ask you a few questions to see if you would like to participate. This should only take a few minutes of your time. This is strictly for research purposes. If you are interested and qualify for the study, we will contact you to schedule a time to participate.

1. Have you participated in a GPM focus group or usability test in the past 6 months?
 - a. Yes
 - b. No
2. Do you, have a commercial or research interest in an electronic health record software or consulting company?
 - a. Yes
 - b. No
3. What is your gender?
 - a. Yes
 - b. No
4. What range below best describes your age?
 - a. 0-9
 - b. 10-19
 - c. 20-29
 - d. 30-39
 - e. 40-49
 - f. 50-59
 - g. 60-69
 - h. 70-79

- i. 80-89
 - j. 90-99
 - k. 100+
 - l. Decline to specify
5. What is the highest level of education you have completed?
- a. No high school degree
 - b. High school graduate, diploma or the equivalent (for example: GED)
 - c. Some college credit, no degree
 - d. Trade/technical/vocational training
 - e. Associate degree
 - f. Bachelor's degree
 - g. Master's degree
 - h. Doctorate degree (e.g., MD, DNP, DMD, PhD)
6. What is your current occupation/role?
- a. Physician
 - b. Physician Assistant
 - c. Nurse Practitioner
 - d. RN/LPN
 - e. Medical Assistant
 - f. Coder
 - g. Scribe
 - h. EHR Administrator
7. Other (please specify)
8. What is your current title?
9. (comment field)
10. How long have you been a professional in the healthcare industry?
- a. Years
 - b. Months
11. How long have you used computers in a professional capacity?
- a. Years
 - b. Months
12. How much GEHRIMED experience do you have?
- a. Years
13. Months
14. List any assistive technology needs you have when using GEHRIMED.
- a. (comment field)
15. Select all healthcare related activities you do on the computer.
- a. Access EHR
 - b. Research
 - c. Reading news
 - d. Scanning/OCR documentation/pictures
 - e. Word processing
 - f. Spreadsheets
 - g. Presentations

- h. Other (please specify)
16. Please provide contact information so we can schedule your participation in the usability study.
- a. Name
 - b. Company
 - c. City/Town
 - d. State/Province
 - e. Email Address
 - f. Phone Number
17. What is your preferred method of contact?
- a. By email
 - b. By phone
 - c. No preference
18. Please provide any additional information concerning how or what time is best when contacting you.
- a. (comment field)

Thank you for your time and information. We will be in contact via email to schedule a time for you to participate.

5.2 Appendix 2: Moderator's Guide for GEHRIMED 2015 Certification Usability Testing

The guide was used by the session administrator to reduce variability in session administration between sessions.

5.2.1 Moderator Administrative Tasks

Prior to testing

1. Confirm schedule with Participants
2. Ensure GEHRIMED lab environment is running properly
3. Ensure lab and data recording equipment is running properly

Prior to each participant

1. Reset application
 - a. Log into GEHRIMED and set the screen to the dashboard
2. Start session recordings with Camtasia
3. Record the follow metadata associated with the session:
 - a. Date & Time
 - b. Participant ID

Prior to each task

1. Remind the participant to they can review the user guides as needed

After each task

1. Answer any questions the user may have

After each participant

1. End session recordings with Camtasia
2. Log out of GEHRIMED

After all testing

1. Back up all video and data files

5.2.2 During Sessions

Orientation

Introduce yourself

Thank them for participating

Reaffirm the session will take less than 90 minutes

Share screen

Ask them to read the consent and make a selection to consent or not

Explain all of the tabs in the browser

Discuss the session

1. We are interested in how easy (or difficult) GEHRIMED is to use, what's useful, and how we can improve it.
2. You will be asked to complete tasks on your own trying to do them as quickly as possible with the fewest possible errors or deviations.
 - a. Do not do anything more than asked.
3. If you get lost or have difficulty I cannot answer or help you with anything to do with the system itself.
4. Please save your detailed comments until the end of a task or the end of the session when we can discuss freely.
5. Please be honest with your opinions. Your participation and feedback help us identify and prioritize improvements to GEHRIMED.
6. The version of the product you will be using today is in a test environment. Because it is a test environment some of the data may be incomplete or not make sense as it is placeholder data.

The general flow of the session will be as follows:

1. You will have a chance to read the instructions
2. You will have a chance to review an abridged version of the user guide you would normally have available and ask any questions about what you reviewed for clarification.
 - a. These are the other tabs in the browser
 - b. Some guides are for multiple tasks
 - c. You may close the tabs for sections that are finished
3. You will be given an opportunity to perform various tasks.
 - a. Feel free to refer back to the instructions and the user guides as much as you want while performing the task
4. When finished with each task, you will have a chance to rate the task.
5. We will then move to the next task.
6. When all tasks are finished you will fill out a short survey.

At the end of each task please let me know you are done by saying something like "I'm done" or "I'm finished". If you feel you cannot complete a task, please let me know.

If for whatever reason you need to stop and can't continue the session let me know and we will stop the session.

Do you have any questions or concerns so far?

Answer any questions or concerns the participant has.

Task Implementation

1. Observe the user reading the instructions and reviewing the user guide, providing answers to any questions they have.
2. When the user is performing the task, whether they are in the application or viewing the instructions or user guide, do not provide direction on how to perform the task. Instead use something like the following answers to direct them to the materials they have available.
 - a. Perform the task as indicated in the instructions

- b. Remember that you can refer back and forth between the application, the instructions, and the user guide.

After tasks are complete

1. Let the user know the tasks are complete and there is a short survey.
2. Once the user completes the survey:
 - a. Thank them for their time
 - b. Let them know how the data will be used for certification and GEHRIMED recommendations for improvement

5.3 Appendix 3: Informed Consent Form

The informed consent form was provided to participants via Survey Monkey at the beginning of the session. All users selected that they consented to being recorded during the session.

The following content is the text of the questionnaire.

Informed Consent

Geriatric Practice Management would like to thank you for participating in this study. The purpose of this study is to evaluate an electronic health records system. If you decide to participate, you will be asked to perform several tasks using the prototype and give your feedback. The study will last about 90 minutes.

Agreement

I understand and agree that as a voluntary participant in the present study conducted by Geriatric Practice Management I am free to withdraw consent or discontinue participation at any time. I understand and agree to participate in the study conducted and recorded by Geriatric Practice Management.

I understand and consent to the use and release of the session recording by Geriatric Practice Management. I understand that the information and recording is for research purposes only and that my name will not be used for any purpose other than research. I relinquish any rights to the recording and understand the recording may be copied and used by Geriatric Practice Management without further permission.

I understand and agree that the purpose of this study is to make software applications more useful and usable in the future.

I understand and agree that the data collected from this study may be shared outside of Geriatric Practice Management. I understand and agree that data confidentiality is assured, because only de-identified data – i.e., identification numbers not names – will be used in analysis and reporting of the results.

I agree to immediately raise any concerns or areas of discomfort with the study administrator. I understand that I can leave at any time.

1. Please select one of the following:

YES, I have read the above statement and agree to be a participant.

NO, I choose not to participate in this study.

5.4 Appendix 4: Task Instructions with Post-Task Rating

Task 1: Clinical Decision Support – Configuration

You are an administrator and you have a new provider, Susan Anderson, for whom you must configure clinical decision support (CDS).

Enable all CDS options for Susan Anderson.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 2: Demographics – Access Demographics

You have a new patient, William Turner, and you want to review their demographics.

Access the patient's demographics to review their information.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 3: Demographics – Record Demographics

You have a new patient, William Turner, and you need to enter their demographic information.

Record the following demographic information for William Turner:

- | | |
|-------------------------|----------------------------------|
| 1. Gender (Sex) | Male |
| 2. Preferred language | Declined |
| 3. Race (multiple) | White, Black |
| 4. Ethnicity (multiple) | Cuban Hispanic, Mexican Hispanic |
| 5. Gender identity | Declined |
| 6. Sexual orientation | Declined |

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 4: Demographics – Change Demographics

You need to change William Turner's demographic information.

Change the following demographic information for William Turner:

- | | |
|-------------------------|------------------------|
| 1. Gender (Sex) | No Change |
| 2. Preferred language | Change to English |
| 3. Race (multiple) | Add Asian |
| 4. Ethnicity (multiple) | Remove Cuban Hispanic |
| 5. Gender identity | Change to Male |
| 6. Sexual orientation | Change to Heterosexual |

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 5: CPOE Labs – Access Lab Orders

Your patient, William Turner, has a lab order.

Access the order to identify what was ordered.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 6: CPOE Labs – Record Lab Orders

Your patient, William Turner, needs an additional lab order.

Record a lab order for VAP cholesterol panel - Serum or Plasma.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 7: CPOE Labs – Change Lab Orders

Your patient, William Turner, needs a change to an existing lab order.

Change the lab order request date for Free T4 and TSH panel - Serum or Plasma to yesterday's date.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 8: CPOE Imaging – Access Imaging Orders

Your patient, William Turner, has an imaging order.

Access the order to identify what was ordered.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 9: CPOE Imaging – Record Imaging Orders

Your patient, William Turner, needs an additional imaging order.

Record an imaging order for RADEX CH 2 VIEWS FRNT&LAT.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 10: CPOE Imaging – Change Imaging Orders

Your patient, William Turner, needs a change to an existing imaging order.

Change the imaging order request date for MRI Tmprmand JT to yesterday's date.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 11: Clinical Decision Support – Trigger a CDS Intervention

Your patient, William Turner, has an incorrect date for an immunization.

Change the immunization date to today's date.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 12: Implants – Access a List of Active Implantable Devices

Your patient, William Turner, mentioned having an implant.

Access the list of implantable devices to identify what implant they have that are currently documented.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 13: Implants – Access an Implantable Device Detail

You see your patient, William Turner, has an active implant.

View the detail for the implant they have.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 14: Implants – Record a Unique Device Identifier

Your patient, William Turner, has an implant not listed in the current list of implants for them.

Record the new implant using the unique device ID:

+B066000325011NS1/\$\$420020216LOT123456789012345/SXYZ456789012345678/16D20130202C1

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 15: Implants – Change the Status for an Implantable Device

Your patient, William Turner, mentioned the original implant in their list was removed.

Change the status of the implant to inactive.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 16: Problem List – Record a Problem in an Encounter

You just visited your patient William Turner and need to add information to the encounter.

In the most current encounter, record the following problem: Acquired Hypothyroidism

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 17: Problem List – Access the Problem List

Your patient, William Turner, has a few problems.

Access the problem list to identify the problems.

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 18: Problem List – Change a Problem in the Problem List

Your patient, William Turner, has a problem in the problem list that should be marked resolved.

Resolve Diabetes Mellitus Type 2 (disorder)

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

Task 19: Clinical information reconciliation and incorporation

Your patient, William Turner, has a CCDA that has been imported from another practice and needs to be reconciled with the existing record.

Reconcile the imported record with the existing record, combining items from both records for the following areas:

1. Medications
2. Medication Allergy
3. Problem List

Overall, this task was... Scale of 1-5 (Very Difficult to Very Easy)

5.5 Appendix 5: Post-Test Questionnaire (System Usability Scale)

End of Session Questions

1. I think that I would like to use this system frequently.
Strongly Disagree Strongly Agree
2. I found the system unnecessarily complex.
Strongly Disagree Strongly Agree
3. I thought the system was easy to use.
Strongly Disagree Strongly Agree
4. I think that I would need the support of a technical person to be able to use this system.
Strongly Disagree Strongly Agree
5. I found the various functions in this system were well integrated.
Strongly Disagree Strongly Agree
6. I thought there was too much inconsistency in this system.
Strongly Disagree Strongly Agree
7. I would imagine that most people would learn to use this system very quickly.
Strongly Disagree Strongly Agree
8. I found the system very cumbersome to use.
Strongly Disagree Strongly Agree
9. I felt very confident using the system.
Strongly Disagree Strongly Agree
10. I needed to learn a lot of things before I could get going with this system.
Strongly Disagree Strongly Agree

5.6 Appendix 6: Participant Demographics

ID	Gender	Age	Education	Occupation/ role	Professional Experience In Months	Comp Exp In Months	Product Exp In Months	Assistive Tech Needs
ID01	Female	30-39	Master's degree	Nurse Practitioner	84	120	21	No
ID02	Male	40-49	Master's degree	Nurse Practitioner	180	300	36	No
ID03	Female	40-49	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Scribe	194	240	12	No
ID04	Female	40-49	Trade/technical/v ocational training	Coder	180	180	84	No
ID05	Female	40-49	Associate degree	RN/LPN	108	288	6	No
ID06	Male	30-39	Master's degree	Nurse Practitioner	144	144	60	No
ID07	Female	20-29	Associate degree	EHR Administrato r	120	120	16	No
ID08	Female	30-39	Associate degree	RN/LPN	91	192	20	No
ID09	Female	50-59	Master's degree	Nurse Practitioner	135	300	74	No
ID10	Female	30-39	Master's degree	Nurse Practitioner	204	204	60	No
ID11	Female	40-49	Trade/technical/v ocational training	RN/LPN	372	192	48	No
ID12	Female	60-69	Doctorate degree (e.g., MD, DNP, DMD, PhD)	Physician	326	41	41	No